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Title: Solving the Inferred Temperature Discrepancy Between Oplib and Atbase.

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Solving the Inferred Temperature Discrepancy Between Oplib and Atbase.

Campaign 4.3 Update

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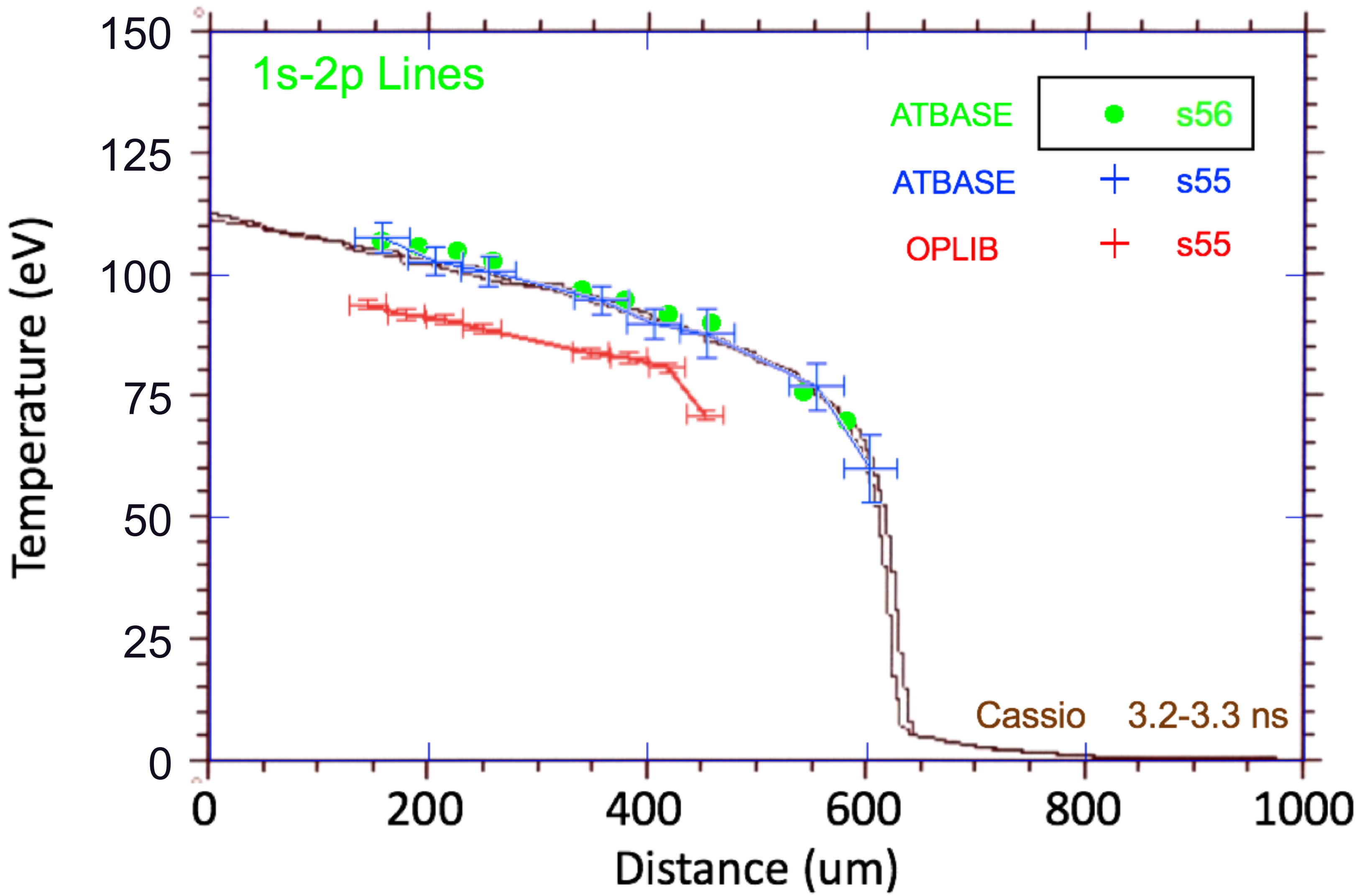
National Nuclear Security Administration

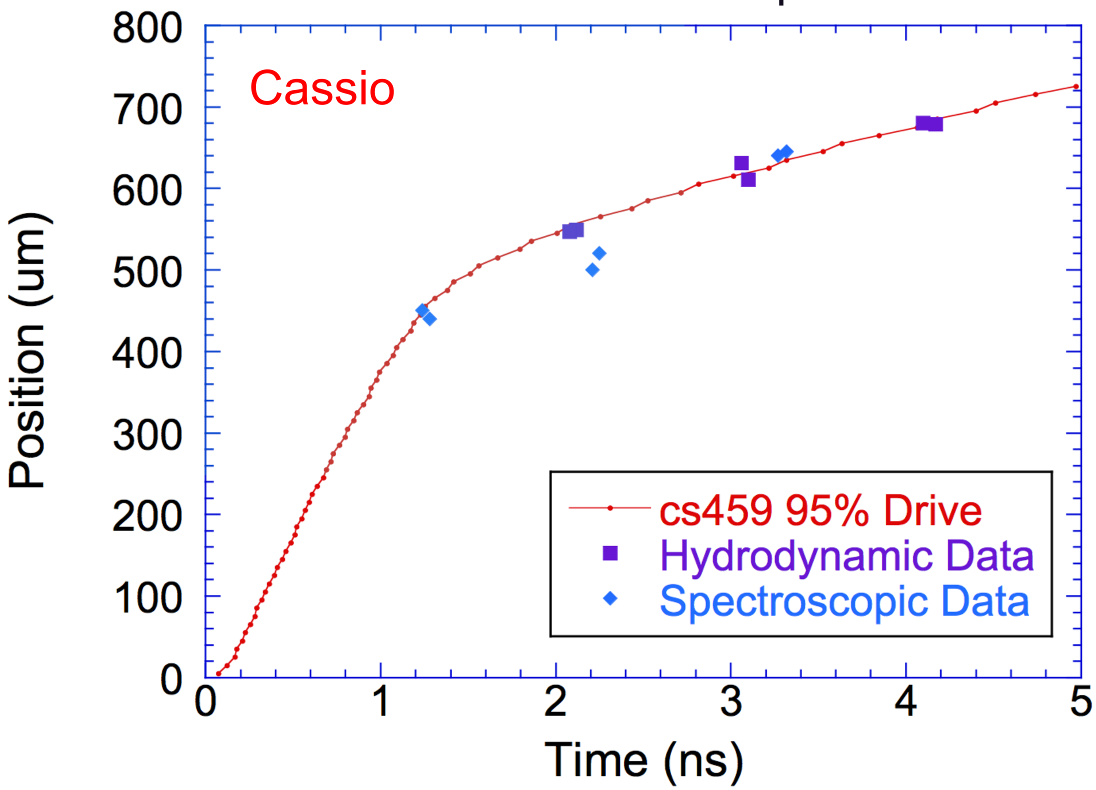
Operated by Los Alamos National Security, LLC for the U.S. Department of Energy's NNSA

PROBLEM: Why does our procedure lead to unphysical results when using the OPLIB opacity tables?



The heat front position vs. time places a stringent constraint on the radiative energy delivered by the hohlraum.

Image and spectral data clearly constrained heat front position



Since

Spatial position was good to 20 microns, foam density to 3%, hohlraum exit hole ~2%.

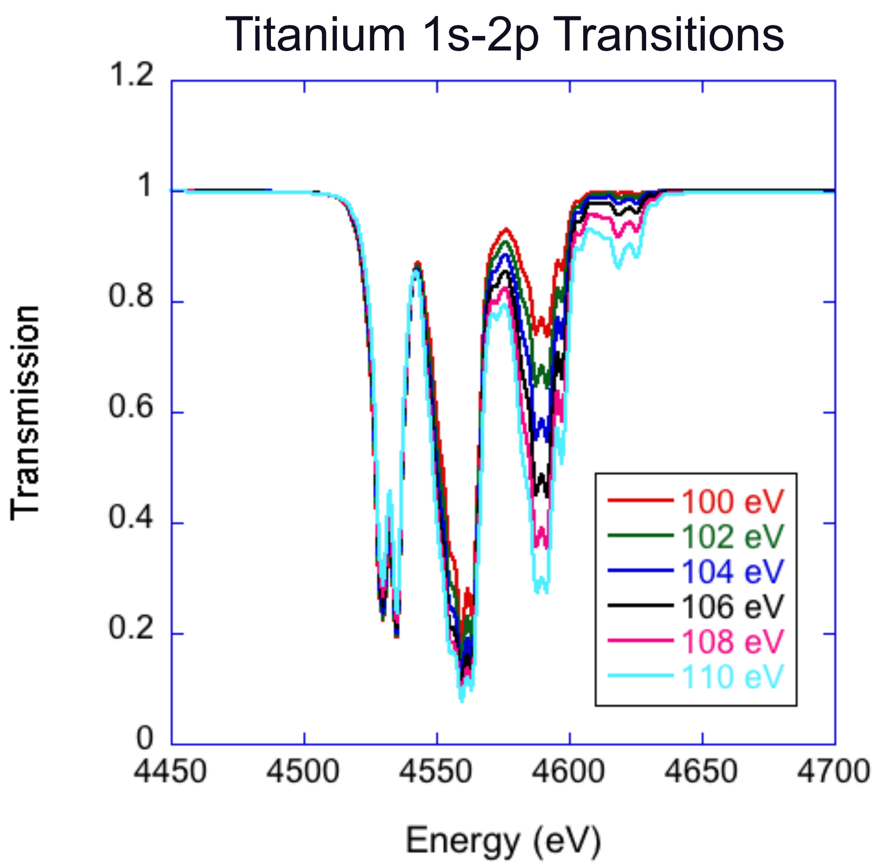
and

Recalling that flux goes as **T^4** so a 20% reduction in temperature is a factor of **TWO** in radiation.

Thus

It was simply **NOT** possible to heat up that much foam with only **HALF** the energy, in the time we had!

The spectral measurement constrains the mean charge state (or Z-bar) of the foam — electron temperature is inferred.

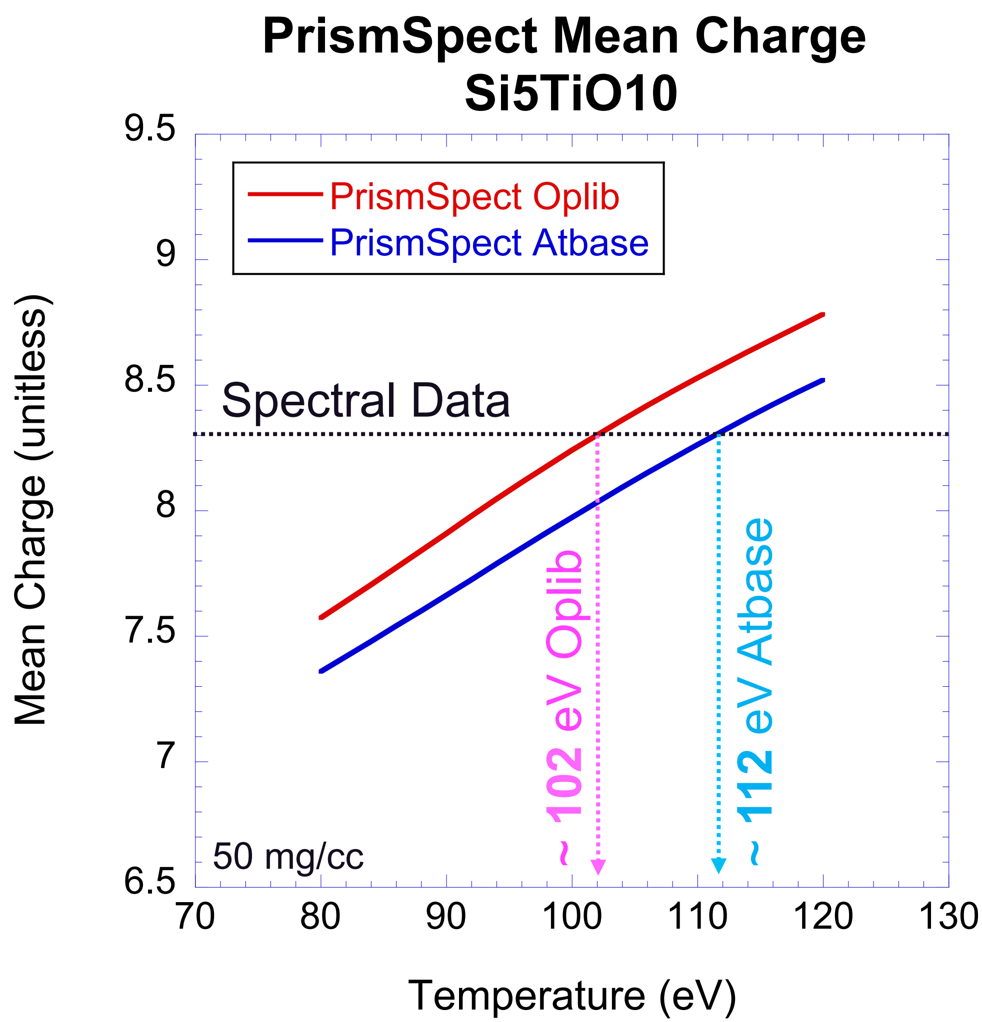


Spectral topology is very sensitive to Z-bar. The difference between the **red** and **cyan** lines above corresponds to a 4% change in Z-bar.

Inferring Temperatures

- Each spectral topology corresponds to a specific mean charge state (Z-bar)
- The opacity tables set forth the relationship between electron temperature and ionization state (i.e. mean charge)
- Using these tables, PrismSpect calculates the spectral topology for a given electron temperature
- By matching this topology to spectral data, the electron temperature is inferred.

Depending on whether PrismSpect employs Oplib or Atbase tables, widely disparate ionization states are predicted.



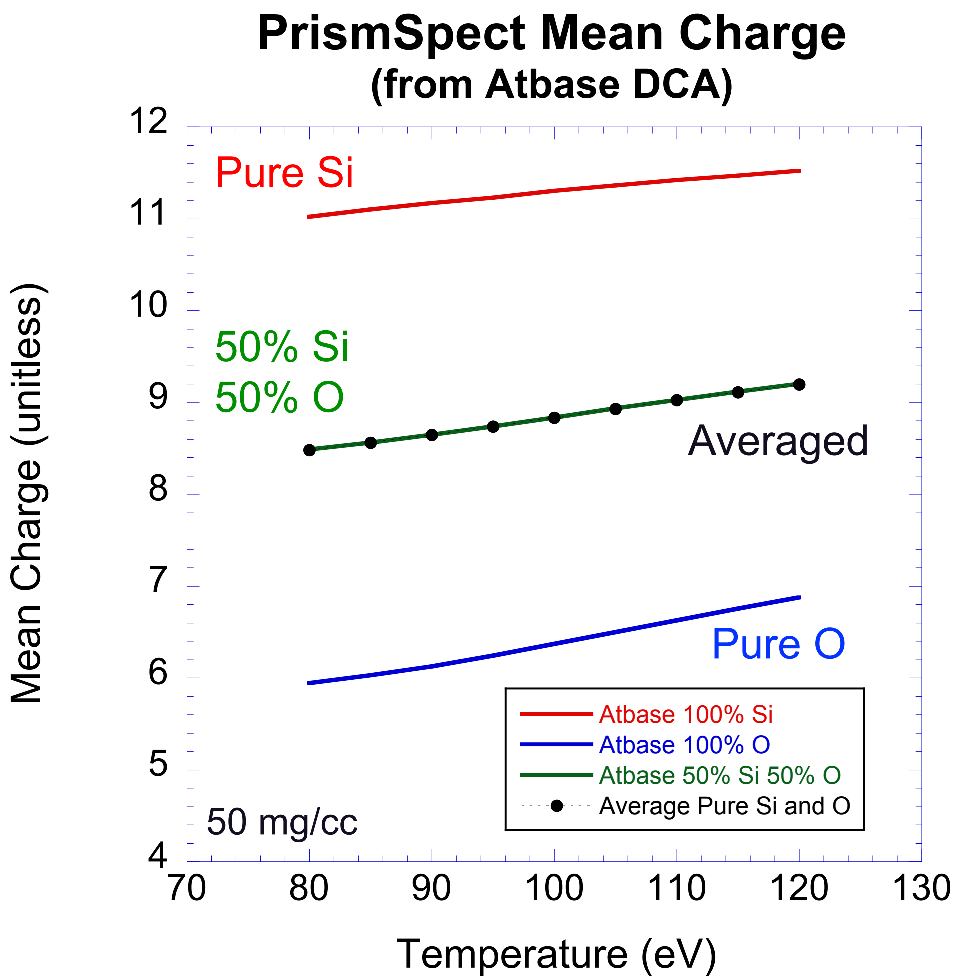
Example

- Assume the spectral data corresponds to Z-bar of 8.3.
- PrismSpect with Oplib would predict this occurs at 102 eV.
- PrismSpect with Atbase would predict this occurs at 112 eV.
- This is a 10 eV discrepancy, and in terms of hohlraum drive would be VERY significant.

Are they really **THAT** different or is something else contributing?

Opacity tables must be built by elements and "mixed" according to the stoichiometry of interest.

Simple Example: **SiO in Atbase**

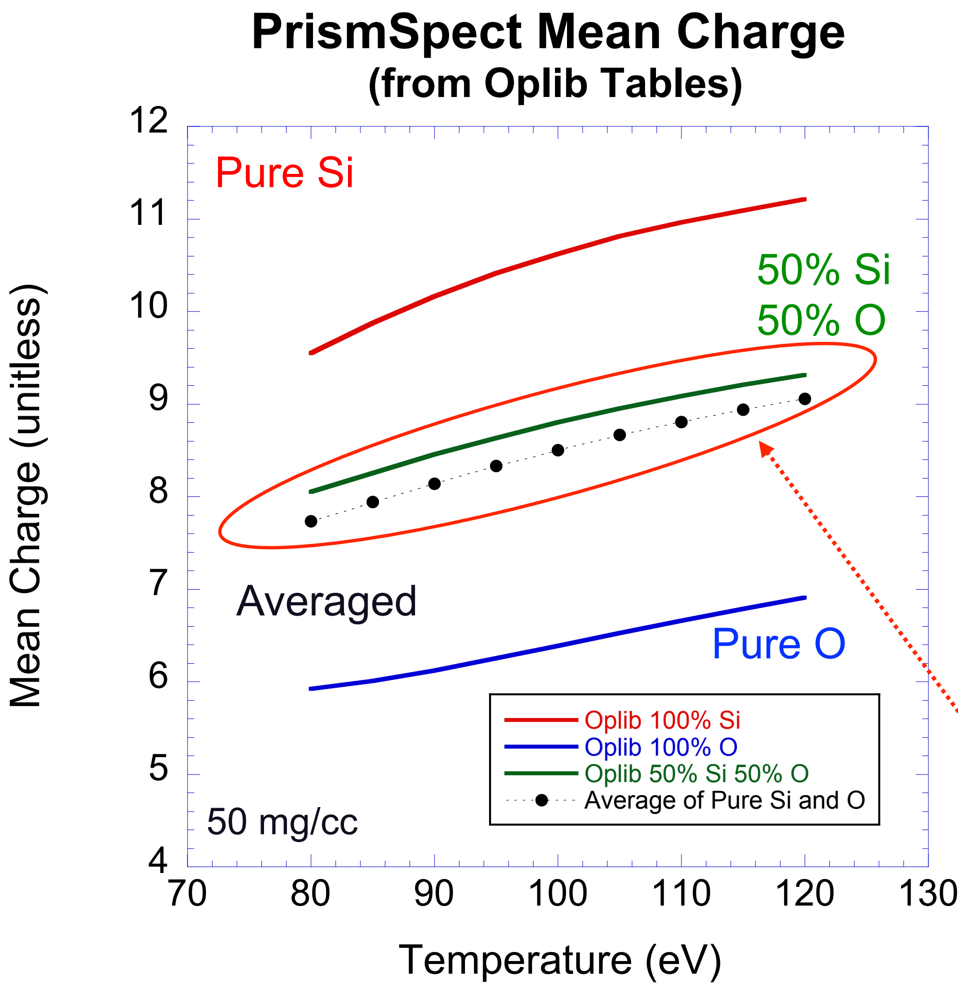


- Three PrismSpect simulations were conducted with Atbase
  - Pure Si @ 50 mg/cc
  - Pure O @ 50 mg/cc
  - Mixed SiO @ 50 mg/cc
- The average was manually calculated from the Pure Si and O results.
- An overlay of the Averaged and Mixed cases show agreement.

Good!

When mixing our Oplib tables, PrismSpect introduces an error, leading to a systematic enhancement of Z-bar.

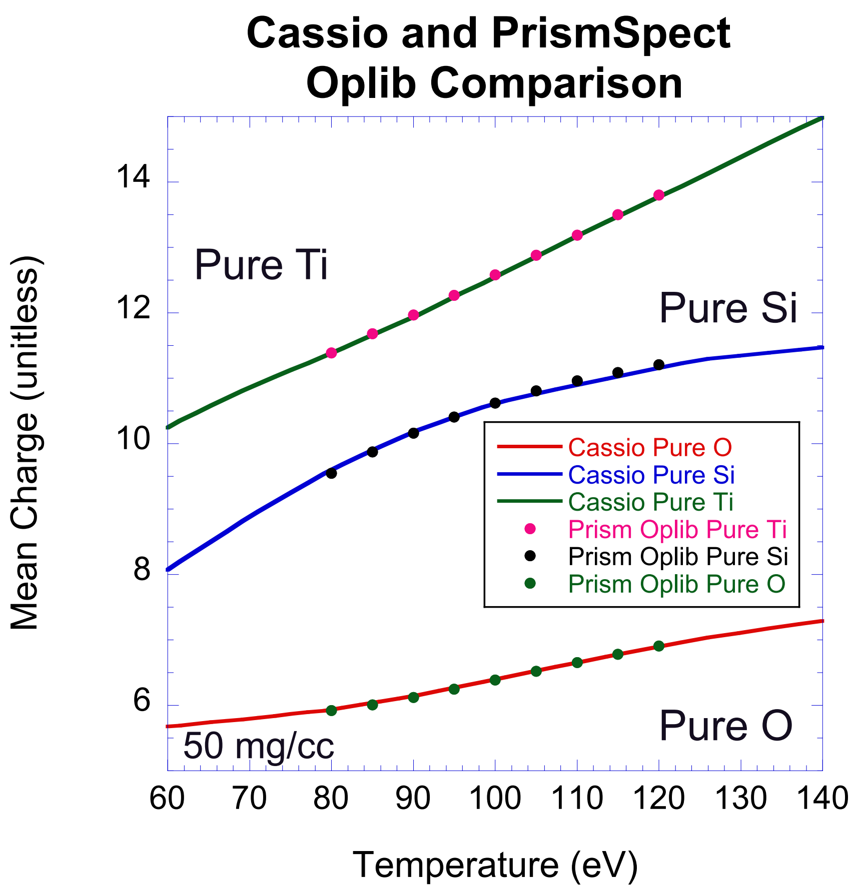
Simple Example: **SiO in Oplib**

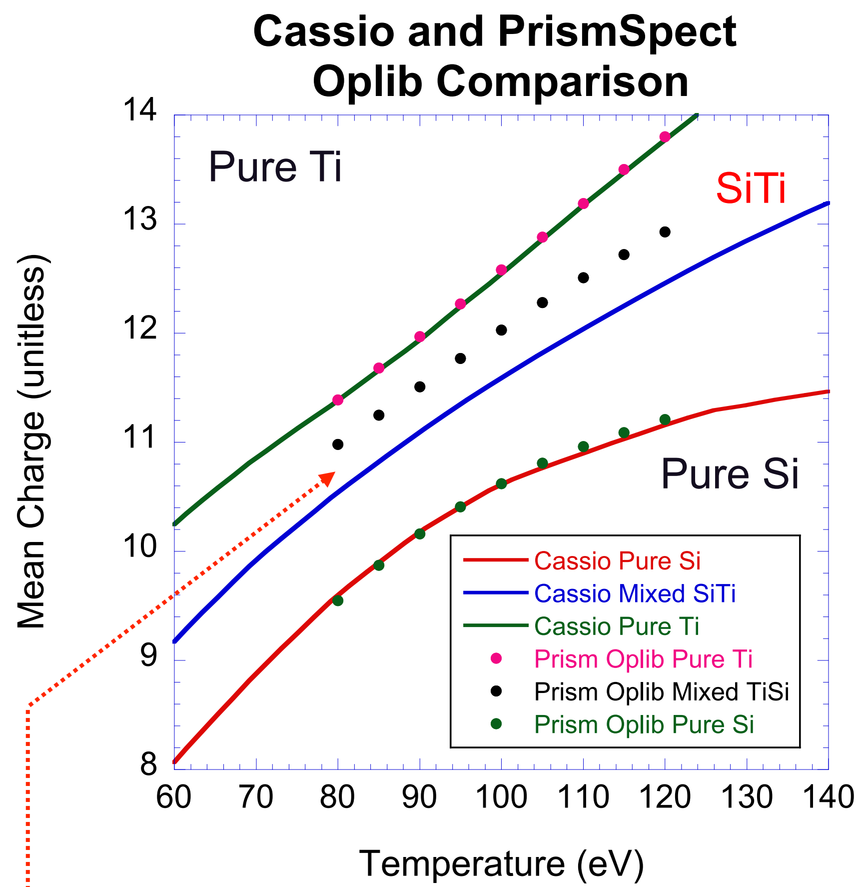


- Three PrismSpect simulations were conducted with Oplib
  - Pure Si @ 50 mg/cc
  - Pure O @ 50 mg/cc
  - Mixed SiO @ 50 mg/cc
- The average was manually calculated from the pure Si and O results.
- An overlay of the Averaged and Mixed cases show **NO** agreement.

Bad!

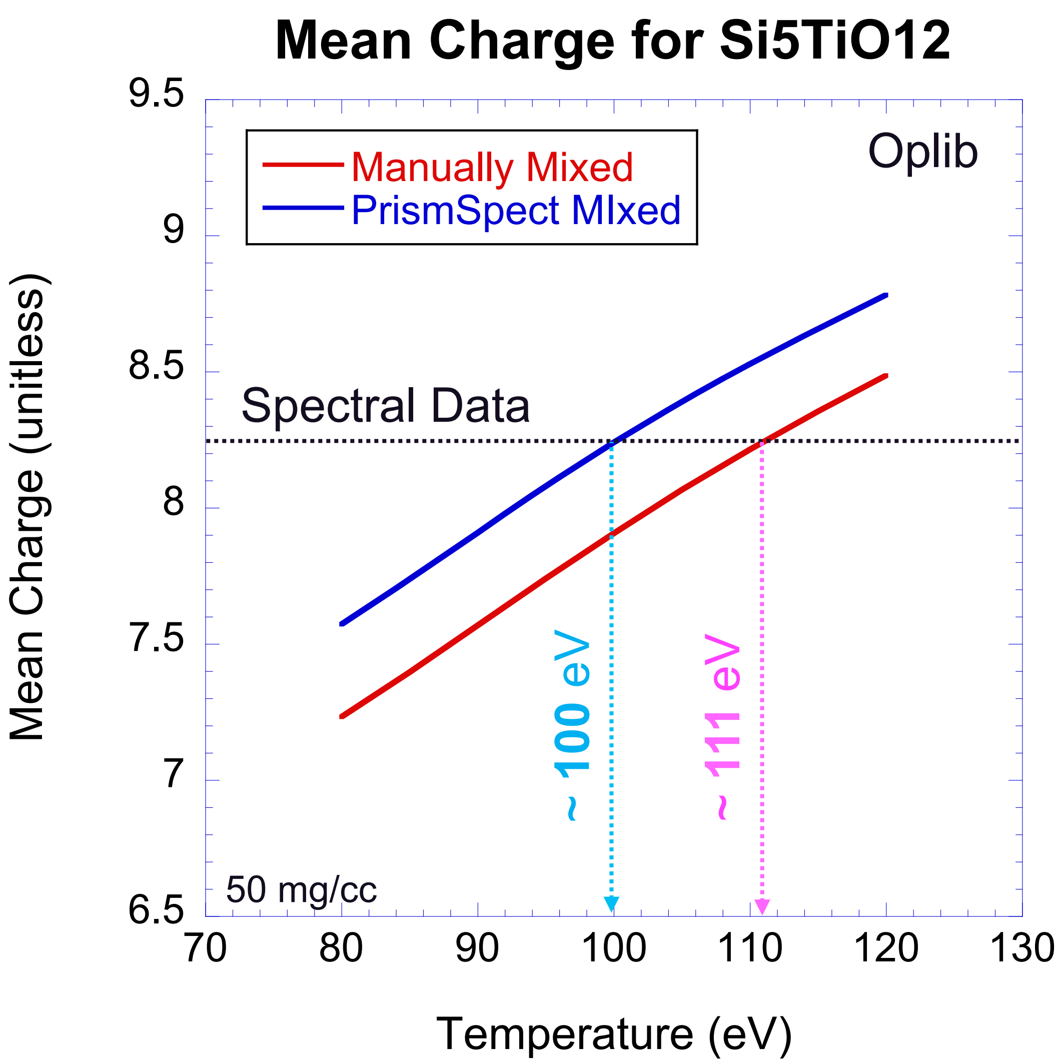
Cassio results show PrismSpect successfully reproduces our Oplib information for pure scenarios – mixing still a problem.





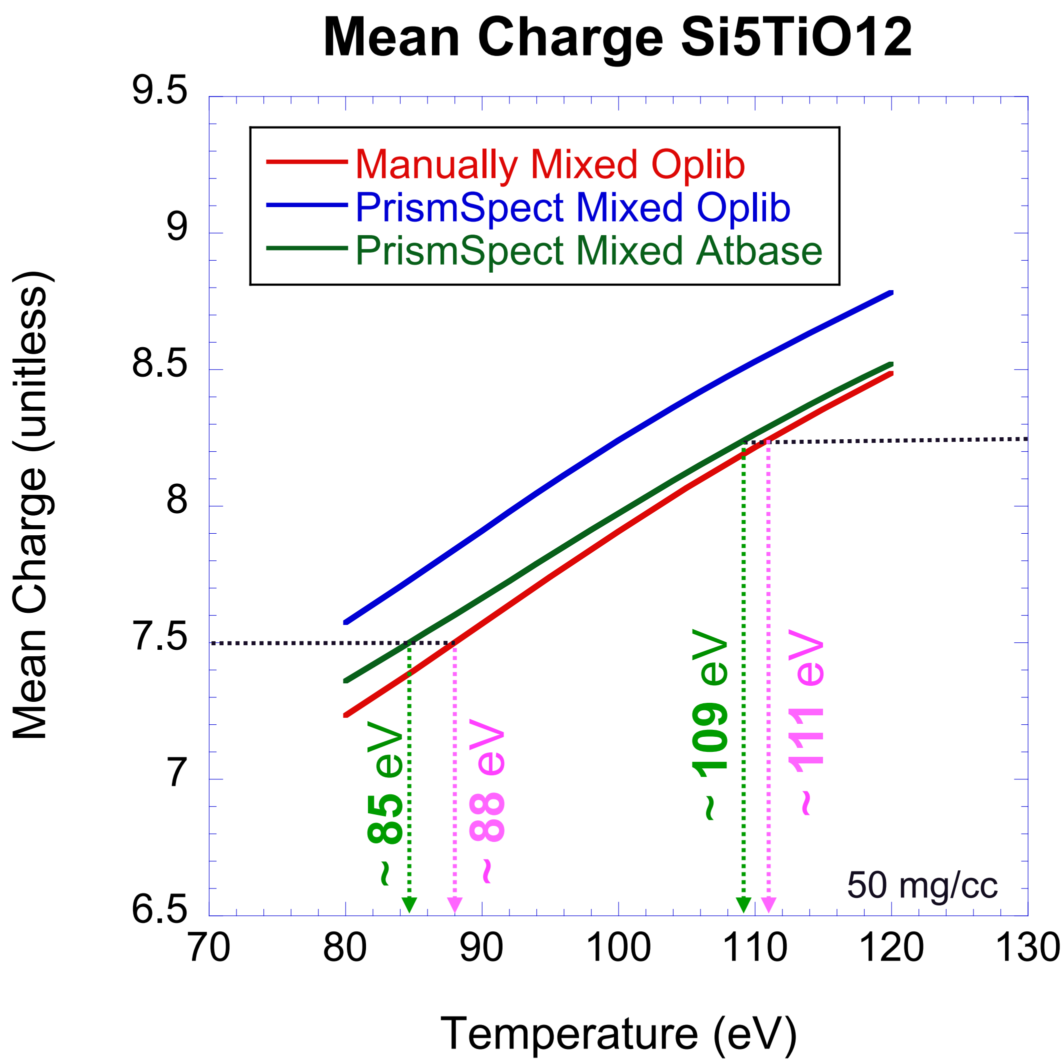
PrismSpect Oplib mixtures still show discrepancy

By manually mixing Oplib tables, we estimate the discrepancy to be around 10-12 eV.



- The manually mixed Z-bar is prescribed as
  - $1/18Z_{Ti}+5/18Z_{Si}+12/18Z_{o}$
- It remains unclear whether
  - A) this result arises from mixing incomplete Oplib tables, or
  - B) is a fundamental error within PrismSpect.
- **Iteration with Prism is recommended.**

When correctly mixed, Atbase and Oplib tables yield similar inferred temperatures – varying by less that 3 eV.



Conclusion

- The systematic reduction in inferred temperatures for COAX experiment arises from an error in how PrismSpect is mixing opacities from our Oplib tables.
- It is unclear whether this is a PrismSpect bug or an incompatibility with our Oplib formatting.
- PrismSpect does, however, successfully reproduce Cassio results when modeling pure material behavior with our Oplib tables.
- When Oplib information is manually mixed, temperature inferences increase by 10ish eV.
- Moreover, the manually mixed Oplib results agree with Atbase to within a few eV.
- **It may be worth contacting Prism for further information.**